1. Networking

1.1. First appearance in English

- Geneva Bible (1560)
  - Thou shalt make unto it a grate like neworke of brasse. *Exodus 27:4*
- KJV
  - And thou shalt make for it a grating of network of brass; and upon the net shalt thou make four brazen rings in the four corners thereof.

1.2. Samuel Johnson's *Dictionary*

- "Any thing reticulated or decussated, at equal distances, with interstices between the intersections."
  - Jack Lynch. Samuel Johnson's *Dictionary*, Selections from the 1755 Work That Defined the English Language.

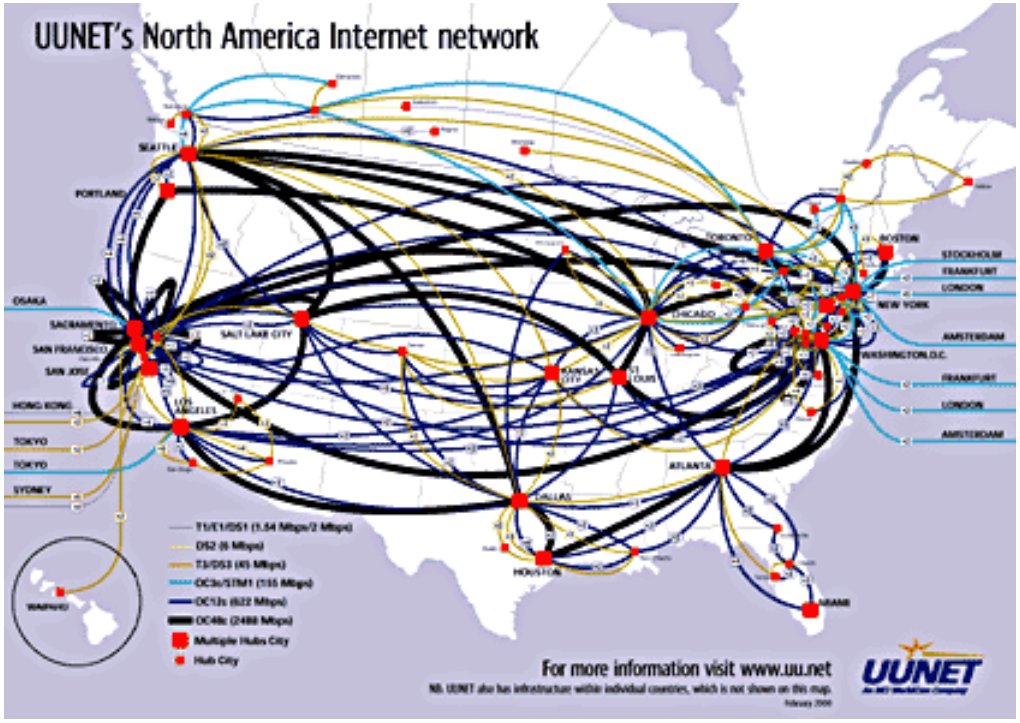
2. Networks--a human tool

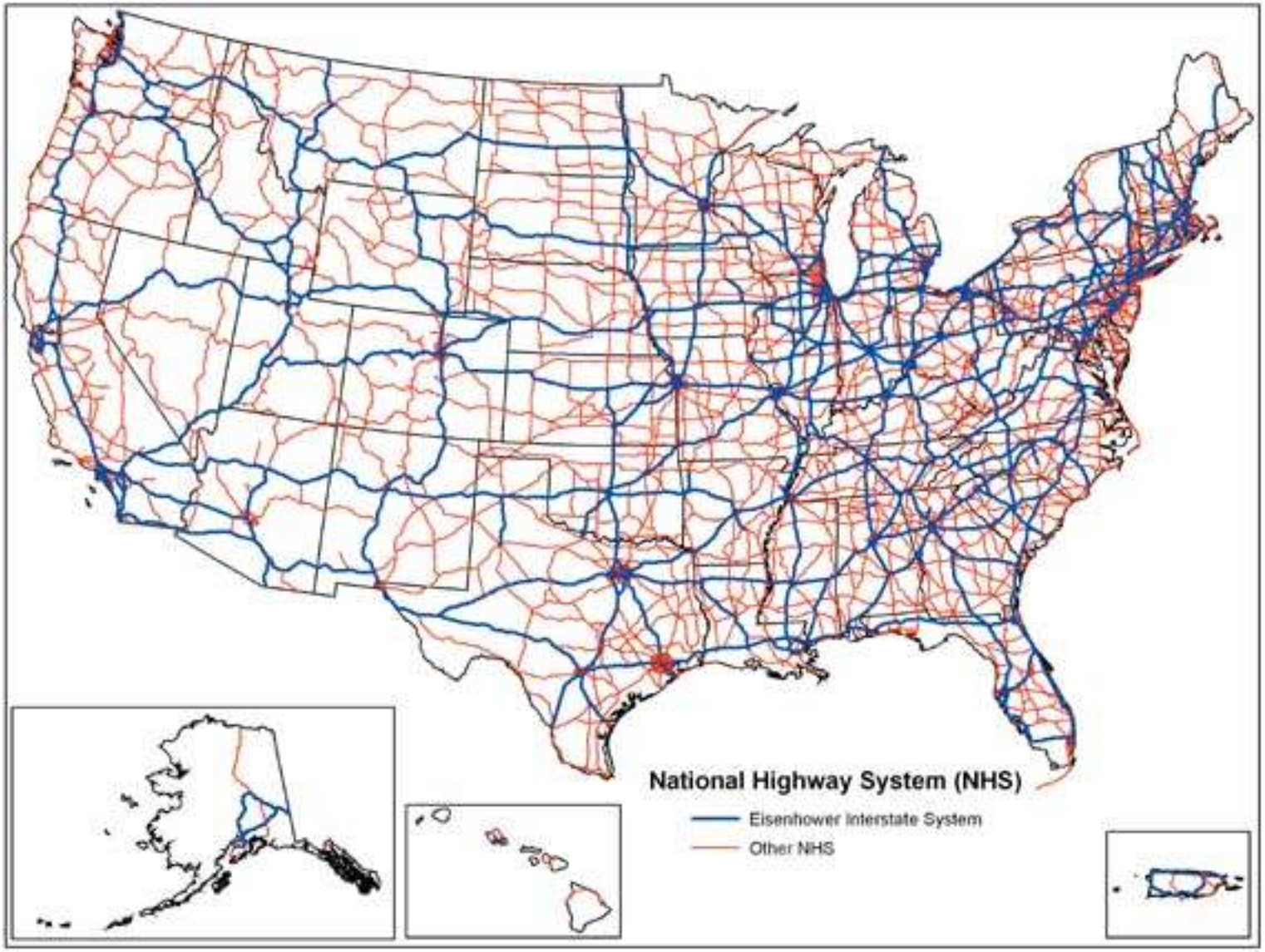
2.1. But first, two concepts

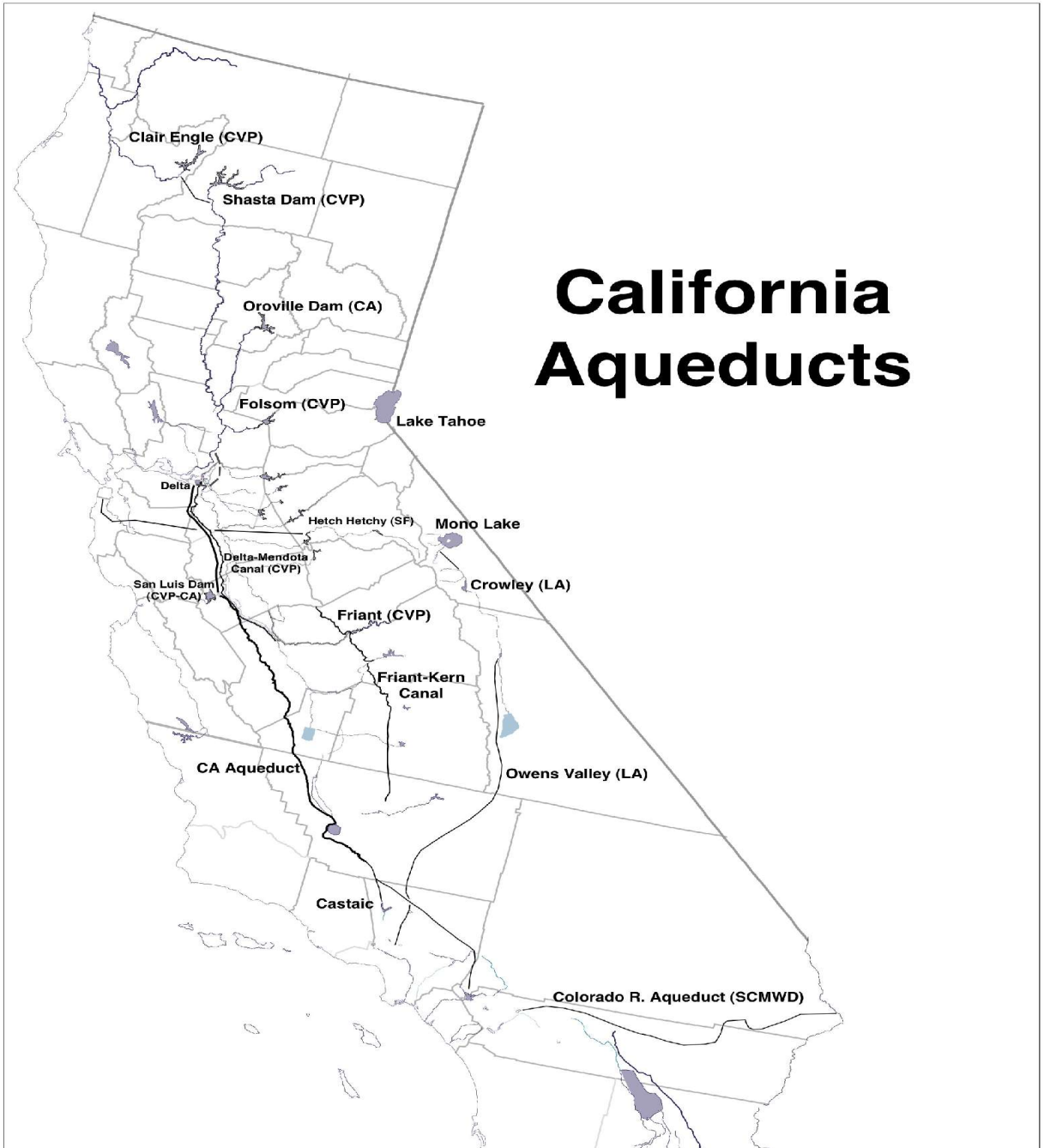
full mesh

partial mesh

2.2. Network maps


UUNET's North America Internet network
SEATTLE
PORTLAND
SACRAMENTO
SAN FRANCISCO
SAN JOSE
SALT LAKE CITY
LOS ANGELES
OSAKA
HONG KONG
TOKYO
TOKYO
SYDNEY
WAIPAHU
TORONTO
CHICAGO
KANSAS CITY
ST LOUIS
ATLANTA
DALLAS
HOUSTON
MIAMI
BOSTON
NEW YORK
WASHINGTON,D.C.
STOCKHOLM
FRANKFURT
LONDON
AMSTERDAM
FRANKFURT
LONDON
AMSTERDAM
T1/E1/DS1 (1.54 Mbps/2 Mbps)
DS2 (6 Mbps)
T3/DS3 (45 Mbps)
OC3c/STM1 (155 Mbps)
OC12c (622 Mbps)
OC48c (2488 Mbps)
Multiple Hubs City
Hub City
For more information visit www.uu.net
NB. UUNET also has infrastructure within individual countries, which is not shown on this map.
February 2000
UUNET
An MCI WorldCom Company


National Highway System (NHS)
Eisenhower Interstate System
Other NHS


California Aqueducts
Clair Engle (CVP)
Shasta Dam (CVP)
Oroville Dam (CA)
Folsom (CVP)
Lake Tahoe
Delta
Hetch Hetchy (SF)
Mono Lake
Delta-Mendota Canal (CVP)
San Luis Dam (CVP-CA)
Crowley (LA)
Friant (CVP)
Friant-Kern Canal
CA Aqueduct
Owens Valley (LA)
Castaic
Colorado R. Aqueduct (SCMWD)

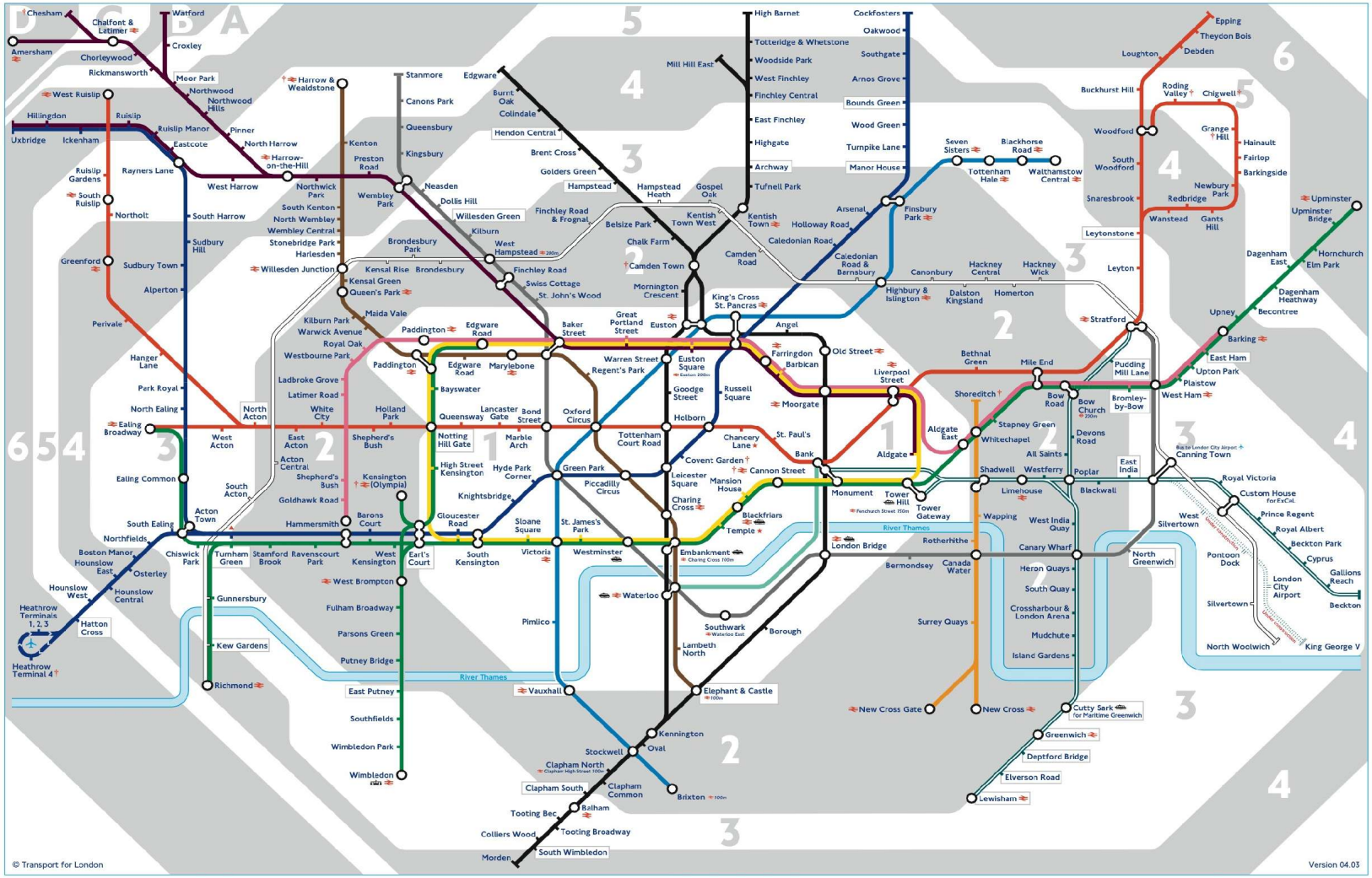
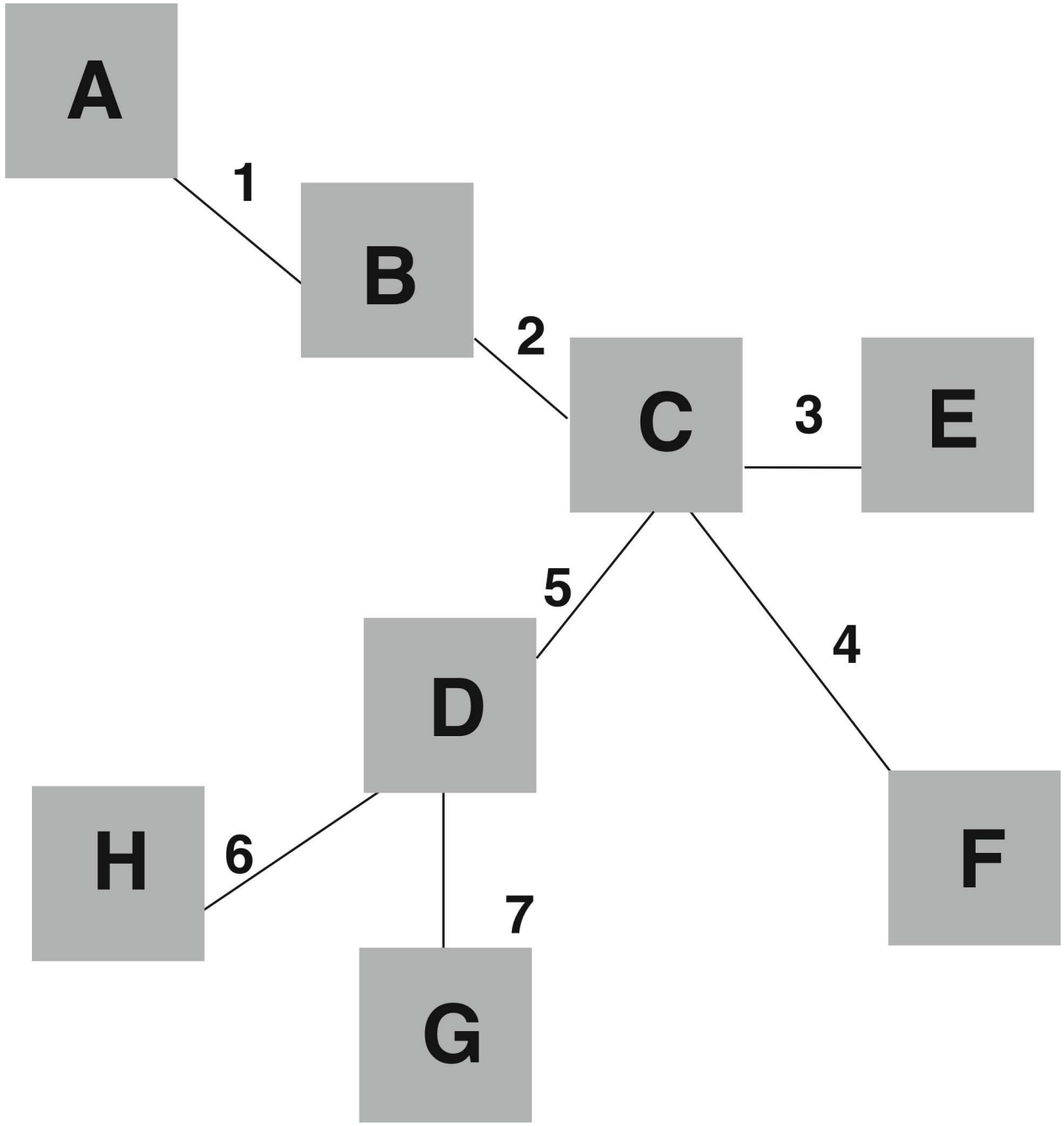

Chesham
Amersham
Chalfont & Latimer
Watford
Croxley
Chorleywood
Rickmansworth
Moor Park
Northwood
Northwood Hills
Pinner
North Harrow
Harrow-on-the-Hill
Harrow & Wealdstone
Stanmore
Edgware
Burnt Oak
Colindale
Hendon Central
Brent Cross
Golders Green
Hampstead
Hampstead Heath
Gospel Oak
Mill Hill East
High Barnet
Totteridge & Whetstone
Woodside Park
West Finchley
Finchley Central
East Finchley
Highgate
Archway
Tufnell Park
Cockfosters
Oakwood
Southgate
Arnos Grove
Bounds Green
Wood Green
Turnpike Lane
Manor House
Seven Sisters
Blackhorse Road
Tottenham Hale
Walthamstow Central
Epping
Theydon Bois
Debden
Loughton
Buckhurst Hill
Roding Valley
Chigwell
Woodford
South Woodford
Grange Hill
Hainault
Fairlop
Barkingside
Newbury Park
Redbridge
Gants Hill
Wanstead
Snaresbrook
Leytonstone
Leyton
Upminster
Upminster Bridge
Dagenham East
Hornchurch
Elm Park
Dagenham Heathway
Becontree
Upney
Barking
East Ham
Upton Park
Plaistow
West Ham
Bromley-by-Bow
Pudding Mill Lane
Mile End
Bethnal Green
Shoreditch
Bow Road
Bow Church
Devons Road
Stratford
Canning Town
Custom House
Royal Victoria
Prince Regent
Royal Albert
Beckton Park
Cyprus
Gallions Reach
Beckton
Pontoon Dock
London City Airport
Silvertown
North Woolwich
King George V
West Silvertown
Poplar
East India
All Saints
Limehouse
Westferry
Shadwell
Wapping
West India Quay
Blackwall
Canary Wharf
Heron Quays
South Quay
Crossharbour & London Arena
Mudchute
Island Gardens
North Greenwich
Cutty Sark for Maritime Greenwich
Greenwich
Deptford Bridge
Elverson Road
Lewisham
Canada Water
Rotherhithe
Surrey Quays
New Cross
New Cross Gate
Canonbury
Highbury & Islington
Dalston Kingsland
Hackney Central
Hackney Wick
Homerton
Finsbury Park
Arsenal
Holloway Road
Caledonian Road
Caledonian Road & Barnsbury
Camden Road
Camden Town
Kentish Town
Kentish Town West
Belsize Park
Chalk Farm
Mornington Crescent
King's Cross St. Pancras
Angel
Old Street
Farringdon
Barbican
Liverpool Street
Moorgate
Bank
St. Paul's
Chancery Lane
Russell Square
Holborn
Euston
Euston Square
Great Portland Street
Warren Street
Regent's Park
Baker Street
Marylebone
Edgware Road
Paddington
Bayswater
Queensway
Lancaster Gate
Bond Street
Oxford Circus
Tottenham Court Road
Goodge Street
Notting Hill Gate
Marble Arch
Hyde Park Corner
Green Park
Piccadilly Circus
Leicester Square
Covent Garden
Cannon Street
Mansion House
Charing Cross
Blackfriars
Temple
Embankment
Waterloo
Westminster
Victoria
St. James's Park
Sloane Square
Knightsbridge
South Kensington
Gloucester Road
Earl's Court
West Kensington
Barons Court
Kensington (Olympia)
Shepherd's Bush
Holland Park
White City
East Acton
Acton Central
North Acton
West Acton
Ealing Broadway
North Ealing
Park Royal
Hanger Lane
Perivale
Ealing Common
South Acton
Acton Town
South Ealing
Northfields
Boston Manor
Hounslow East
Hounslow West
Hounslow Central
Osterley
Chiswick Park
Turnham Green
Stamford Brook
Ravenscourt Park
Hammersmith
Goldhawk Road
Shepherd's Bush
Wood Lane
Latimer Road
Ladbroke Grove
Westbourne Park
Royal Oak
Warwick Avenue
Maida Vale
Kilburn Park
Queen's Park
Kensal Green
Willesden Junction
Kensal Rise
Brondesbury
Brondesbury Park
Willesden Green
Kilburn
West Hampstead
Finchley Road
Finchley Road & Frognal
Swiss Cottage
St. John's Wood
Harlesden
Stonebridge Park
Wembley Central
North Wembley
South Kenton
Kenton
Preston Road
Northwick Park
Wembley Park
Neasden
Dollis Hill
Queensbury
Kingsbury
Canons Park
Uxbridge
Hillingdon
Ickenham
Ruislip
Ruislip Manor
Eastcote
Ruislip Gardens
South Ruislip
Northolt
Greenford
Rayners Lane
West Harrow
South Harrow
Sudbury Hill
Sudbury Town
Alperton
West Ruislip
Richmond
Kew Gardens
Gunnersbury
Turnham Green
Chiswick Park
Heathrow Terminals 1, 2, 3
Heathrow Terminal 4
Hatton Cross
West Brompton
Fulham Broadway
Parsons Green
Putney Bridge
East Putney
Southfields
Wimbledon Park
Wimbledon
Pimlico
Vauxhall
Lambeth North
Southwark
Borough
Elephant & Castle
Kennington
Oval
Stockwell
Clapham North
Clapham South
Clapham Common
Brixton
Balham
Tooting Bec
Tooting Broadway
Colliers Wood
South Wimbledon
Morden
River Thames
Bermondsey
London Bridge
Monument
Tower Hill
Tower Gateway
Aldgate
Aldgate East
Shoreditch
Whitechapel
Stepney Green
Limehouse
Wapping
Rotherhithe
Bermondsey
Canada Water
Surrey Quays
New Cross
New Cross Gate
Greenwich
Cutty Sark
Deptford Bridge
Elverson Road
Lewisham

СХЕМА ЛИНИЙ СКОРОСТНОГО ТРАНСПОРТА МОСКВЫ

RAPID TRANSIT SYSTEMS OF MOSCOW


RED LINE
Shady Grove
Rockville
Twinbrook
White Flint
Grovesnor-Strathmore
Medical Center
Bethesda
Friendship Heights
Tenleytown
Van Ness
Cleveland Park
Woodley Park
Glenmont
Wheaton
Forest Glen
Silver Spring
Takoma
GREEN LINE
Greenbelt
College Park
PG Plaza
West Hyattsville
Georgia Ave.
Fort Totten
Columbia Heights
Brookland - CUA
U Street
Rhode Island Ave.
Shaw
New York Ave.
Dupont Circle
Farragut North
McPherson Sq
Gallery Place
Mount Vernon Square
Union Station
New Carrollton
Landover
Cheverly
Deanwood
Minn. Ave.
Benning Road
Capitol Heights
Addison Road - Seat Pleasant
Morgan Boulevard
Largo Town Center
Rosslyn
Foggy Bottom - GWU
Farragut West
Metro Center
Federal Triangle
Smithsonian
Archives - Navy Memorial
L'Enfant Plaza
Federal Center SW
Capitol South
Eastern Market
Potomac Ave.
Stadium-Armory
ORANGE LINE
Vienna/Fairfax
Dunn Loring
West Falls Church
East Falls Church
Ballston
Virginia Sq - GMU
Clarendon
Court House
Arlington Cemetery
Pentagon
YELLOW LINE
Pentagon City
Crystal City
National Airport
Braddock Road
King Street
Eisenhower Avenue
Huntington
Van Dorn Street
BLUE LINE
Franconia - Springfield
Waterfront - SEU
Navy Yard
Anacostia
Congress Heights
Southern Ave
Naylor Road
Suitland
Branch Ave
N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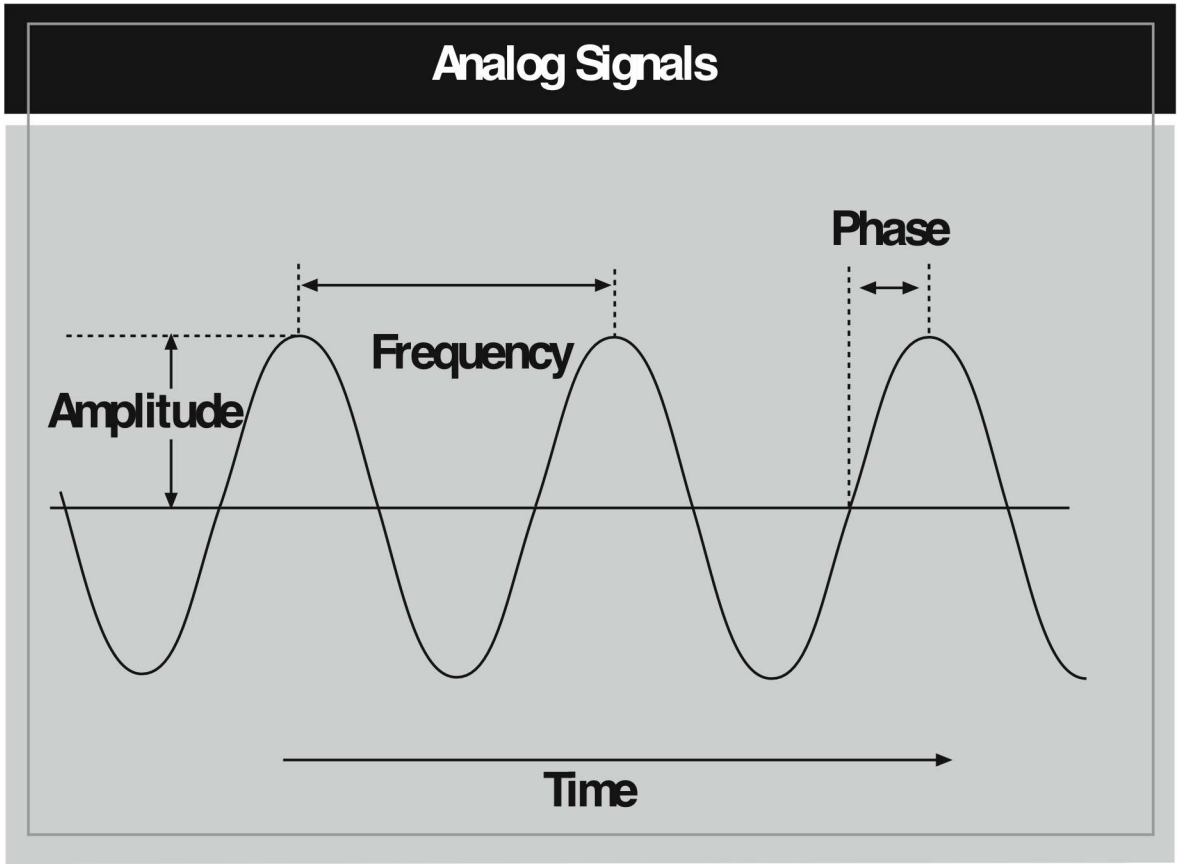
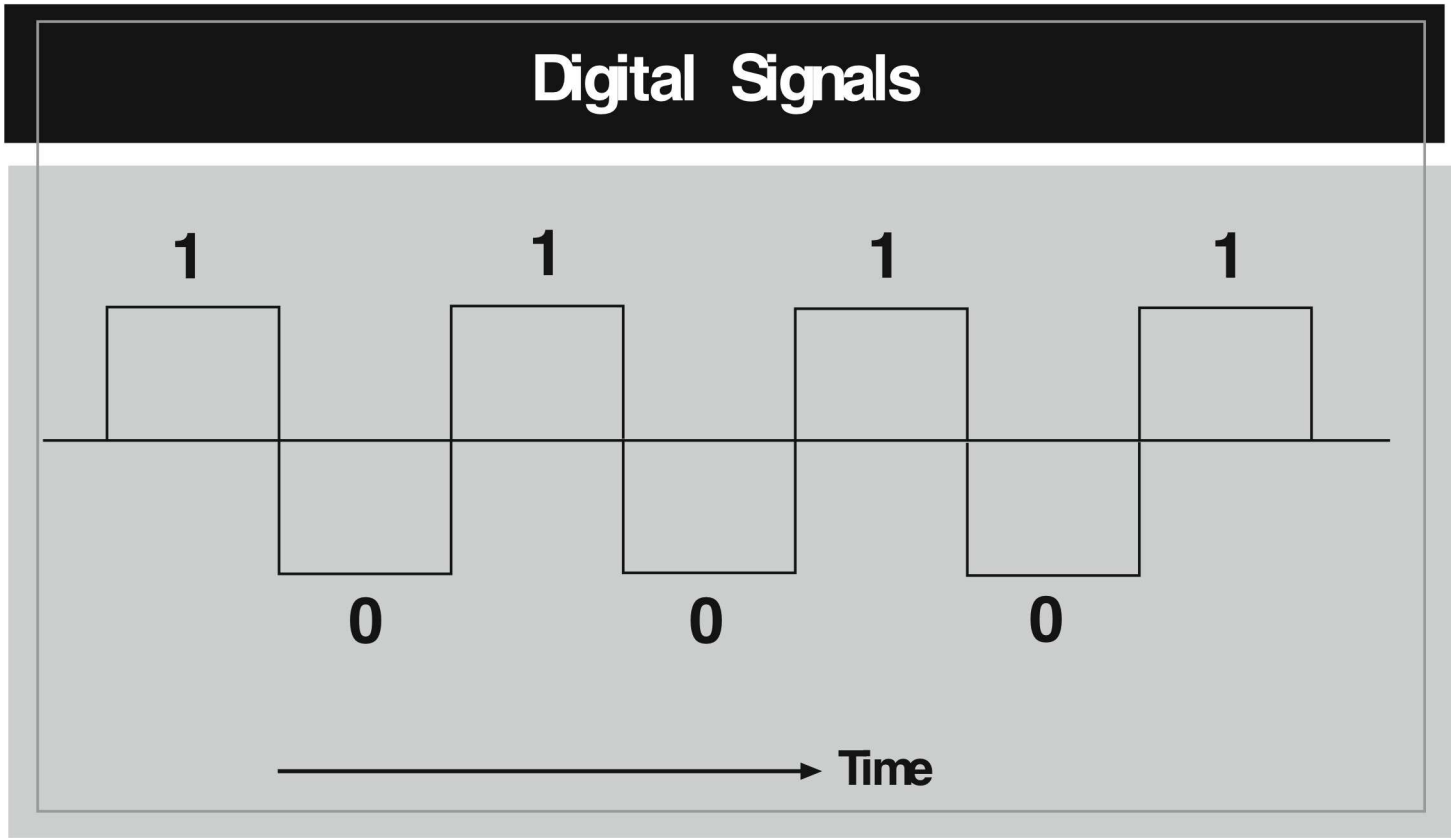
3. Signalling

3.1. Analog



3.2. Digital



3.3. Digital signals/formats are better for most current purposes

- Analog - “generations”
- DSP - Digital signal processing
  - Copies as good as (or better) than the original

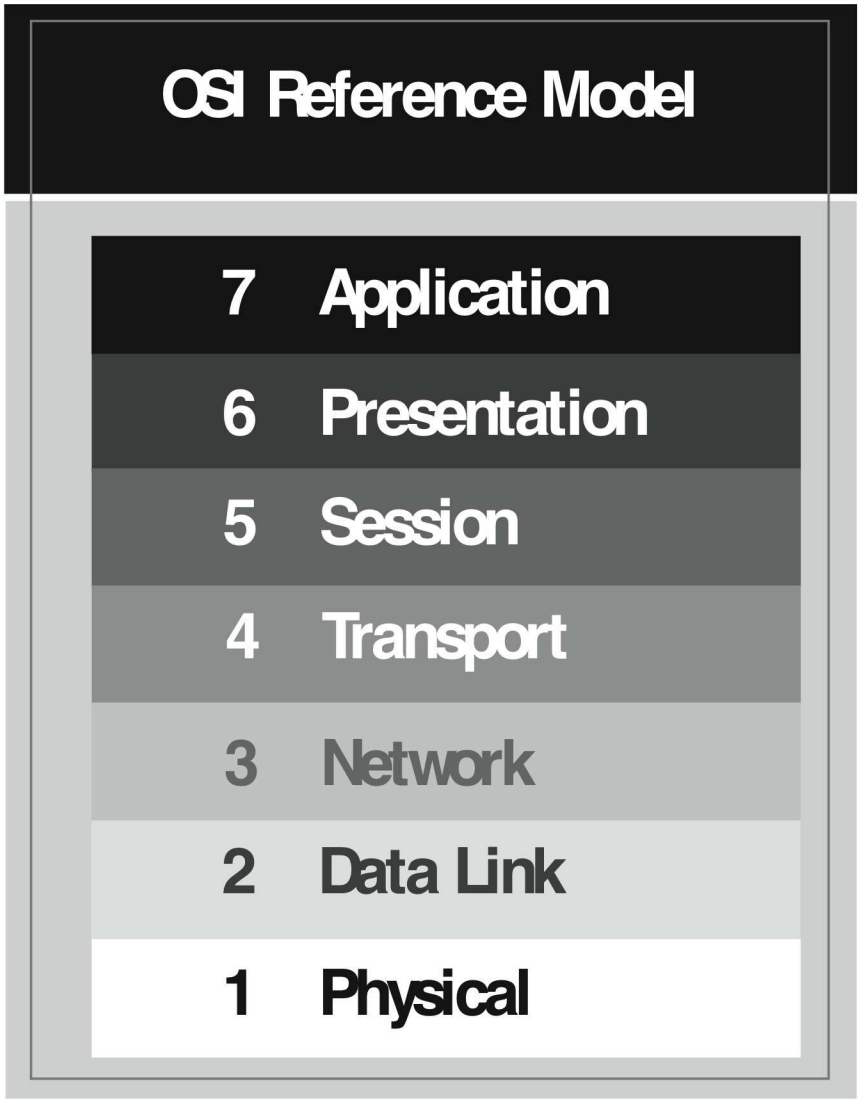
3.4. Analog networks

- Ma Bell
- Circuits--“circuit switched”

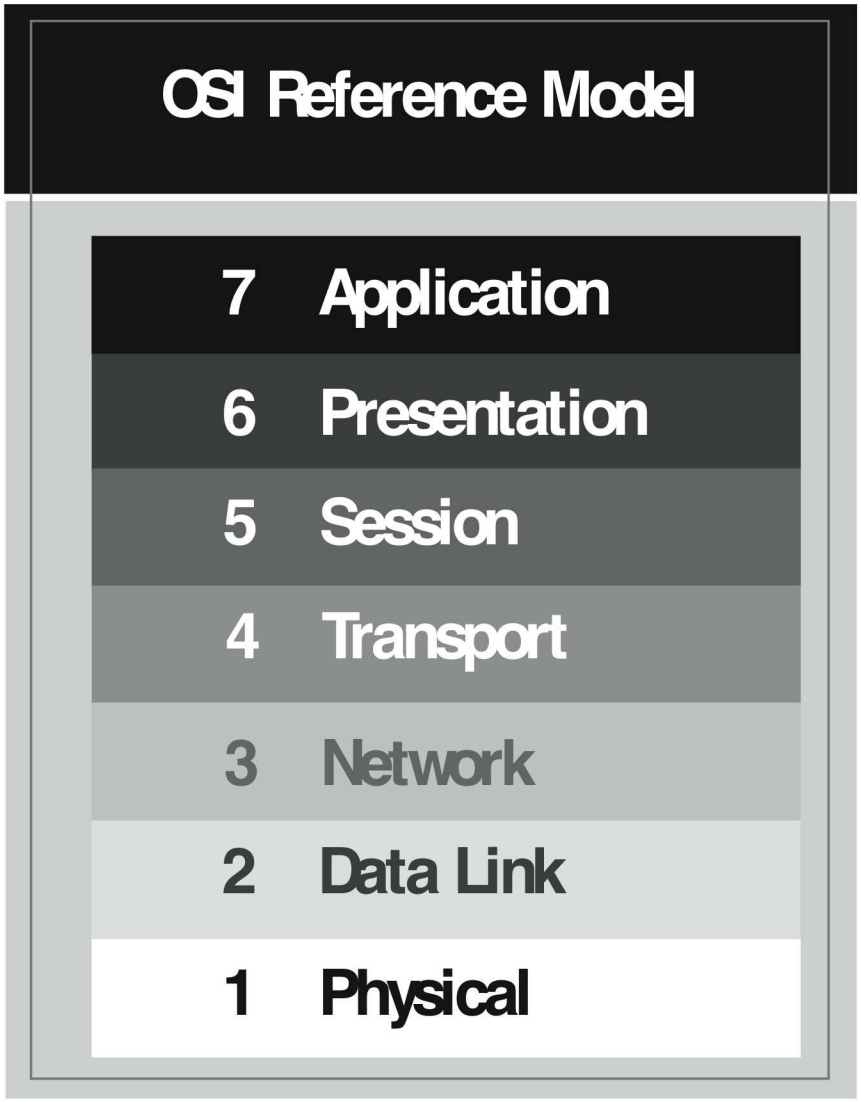
4. Digital Computer Networks

- Packets and frames
- “Packet switched”

4.1. OSI Reference Model


OSI Reference Model
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical

- All People Seem To Need Data Processing


OSI Reference Model
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical

4.2. Protocols

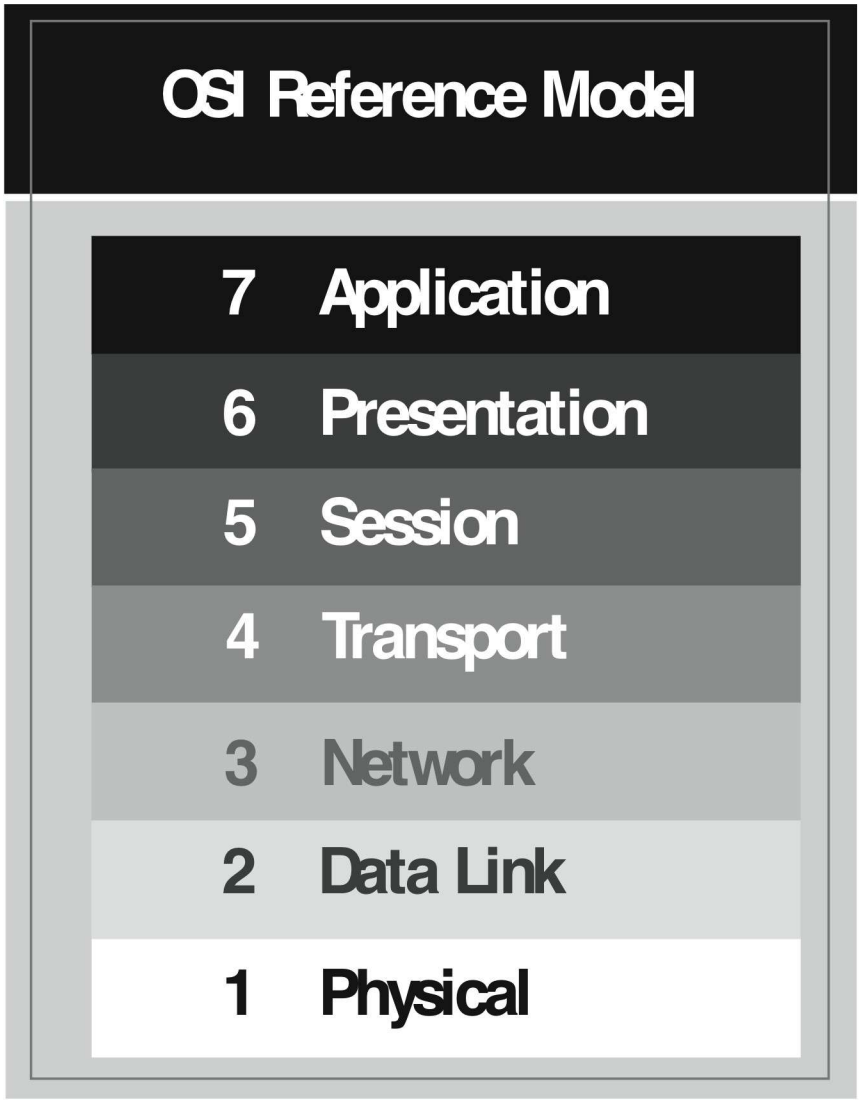
- Rules for communications
  - TCP/IP
  - IPX/SPX
  - IEEE 802.3 (Ethernet)
  - SONET

4.3. Standards

- Agreed upon principles behind communications protocols

4.4. Code

- Any standard relationship between signal and meaning.


OSI Reference Model
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical

4.5. LANs and WANs

- LAN = Local Area Network
- WAN = Wide Area Network

5. Tripping through the layers

5.1. LANs first

5.1.1. Layer 1

- Media
  - Wires, cable, etc
  - WiFi
- Signalling
  - Electrical
  - Optical (light)

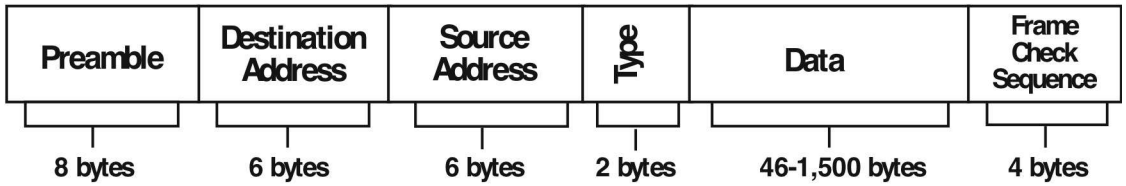
5.1.2. Layer 2

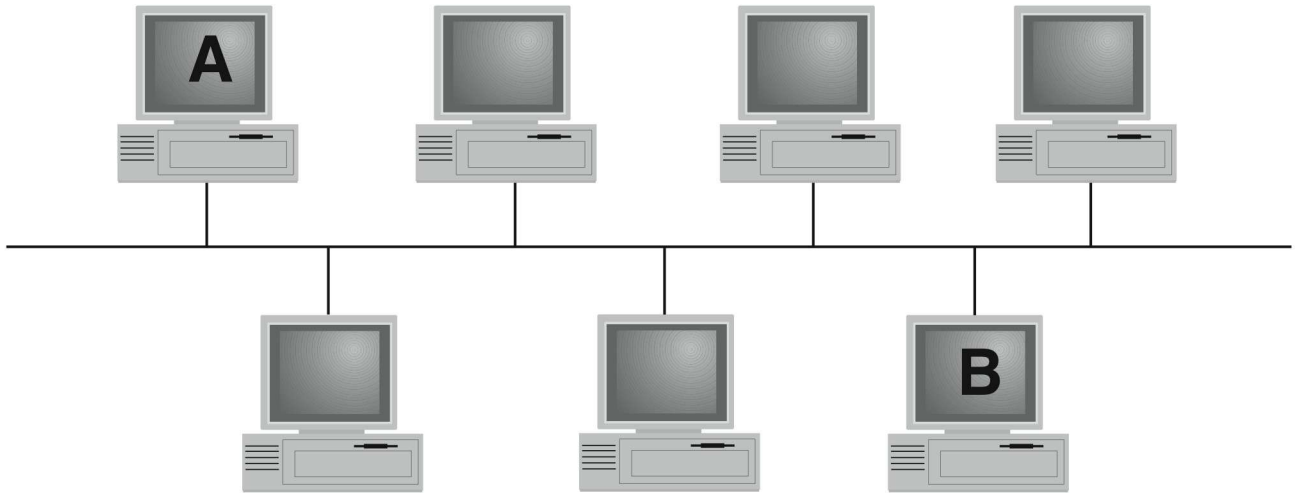
5.1.3. Packets (or frames)

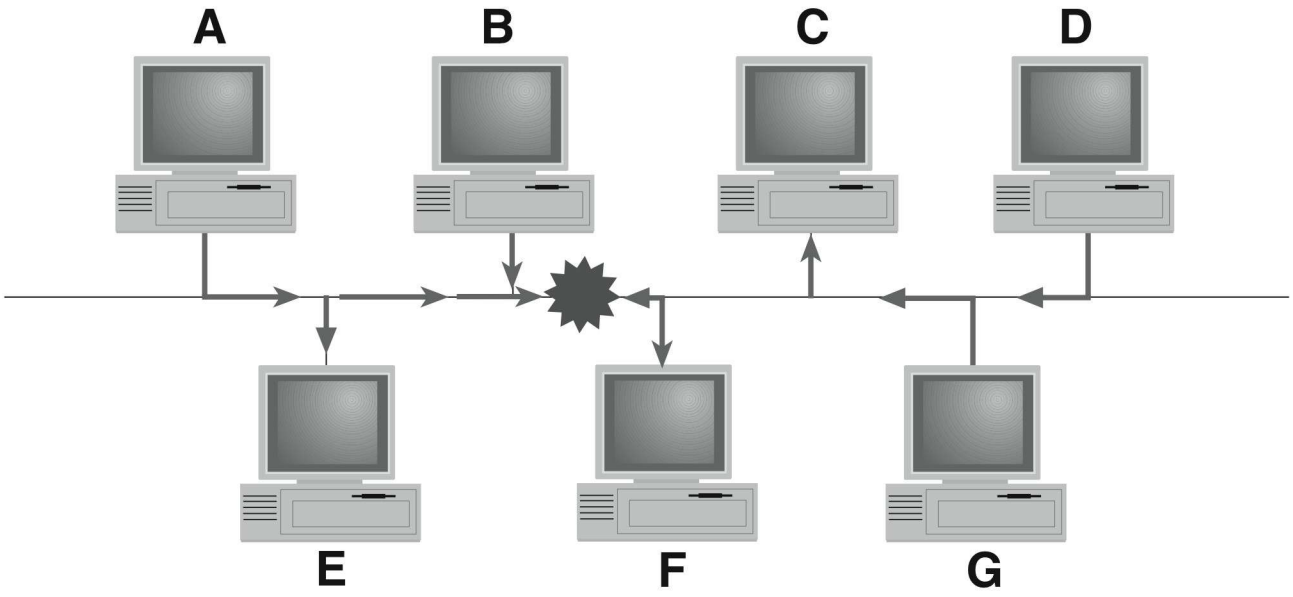
- “A bundle of data…”
- 1s and 0s
  - “bits”
- 8 bits = “octets” or “bytes”

5.1.3.1. People packet

5.1.4. Ethernet frame




A
B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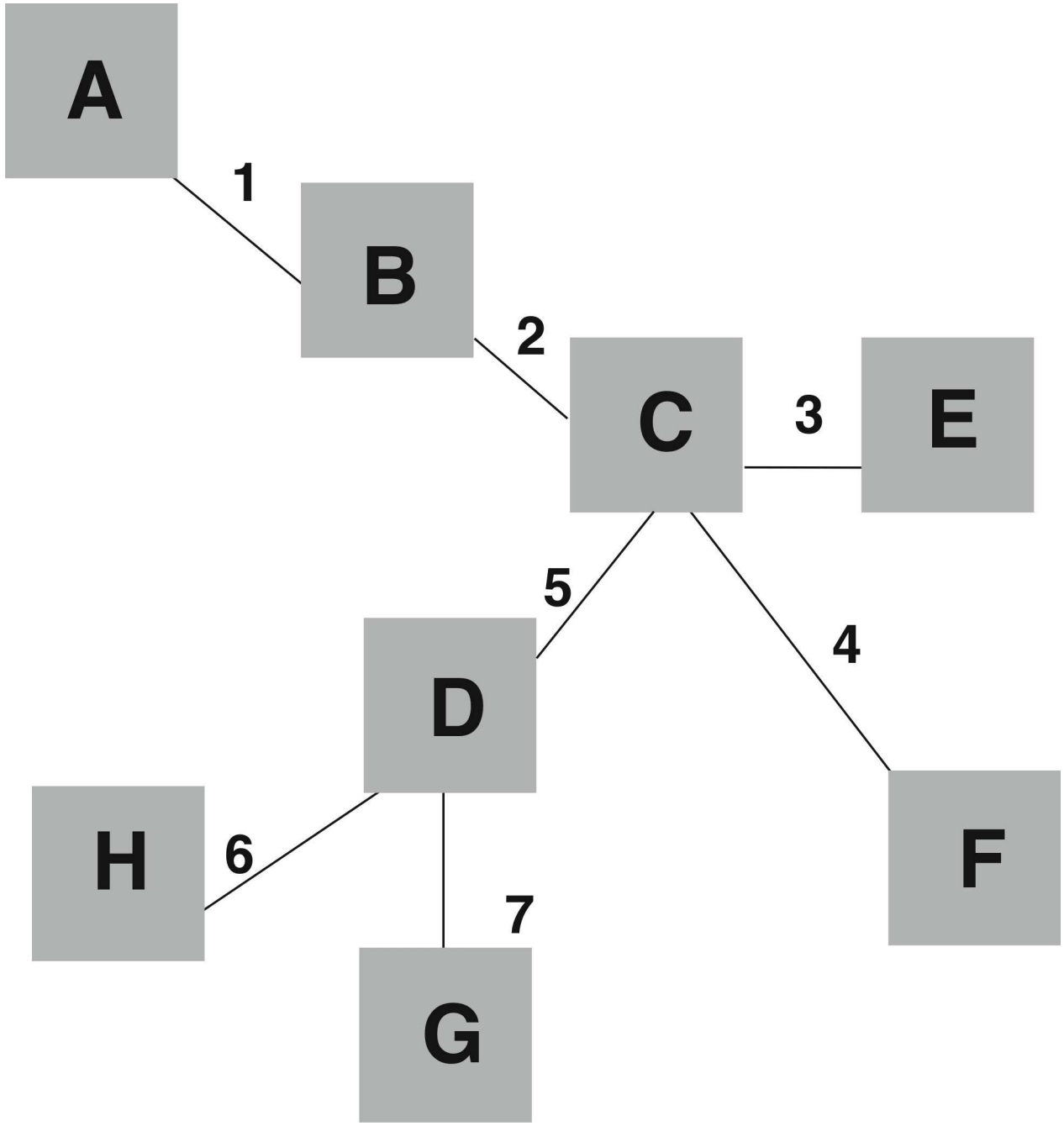
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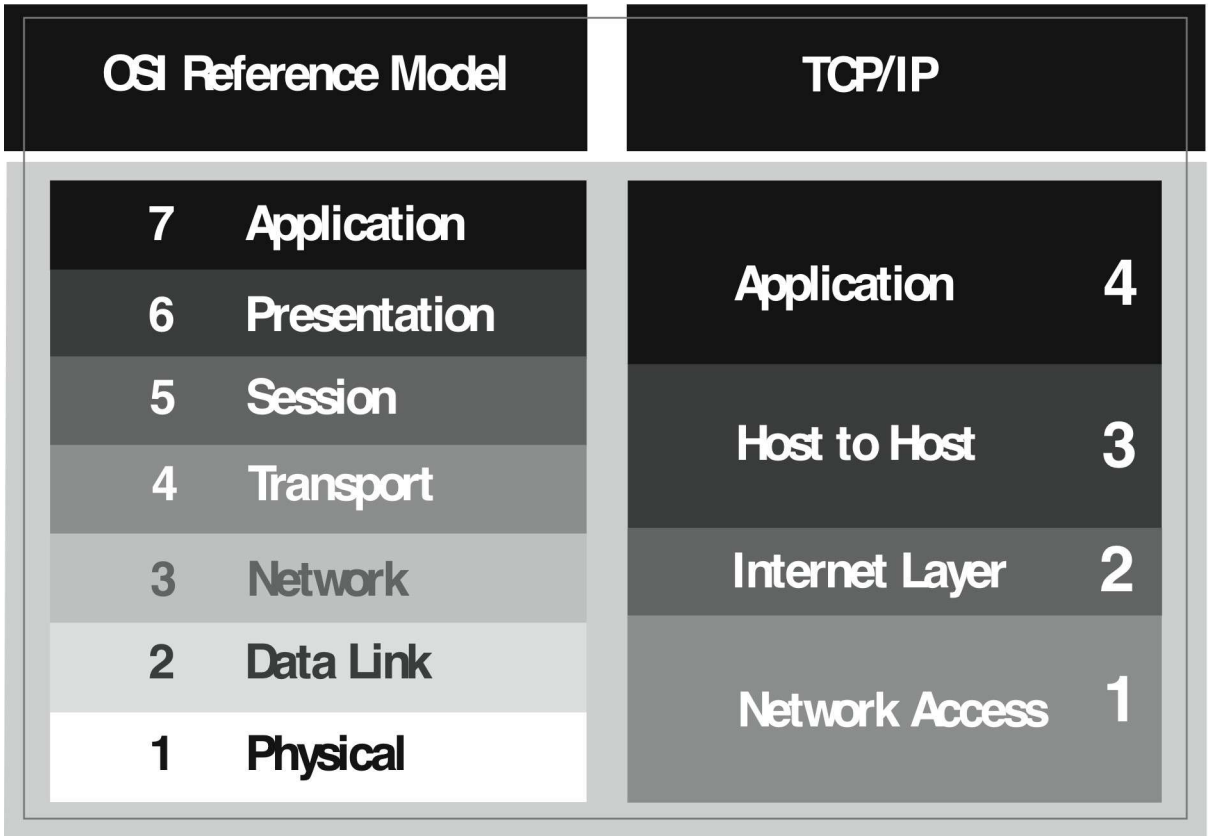
5.2. Wide Area Networks

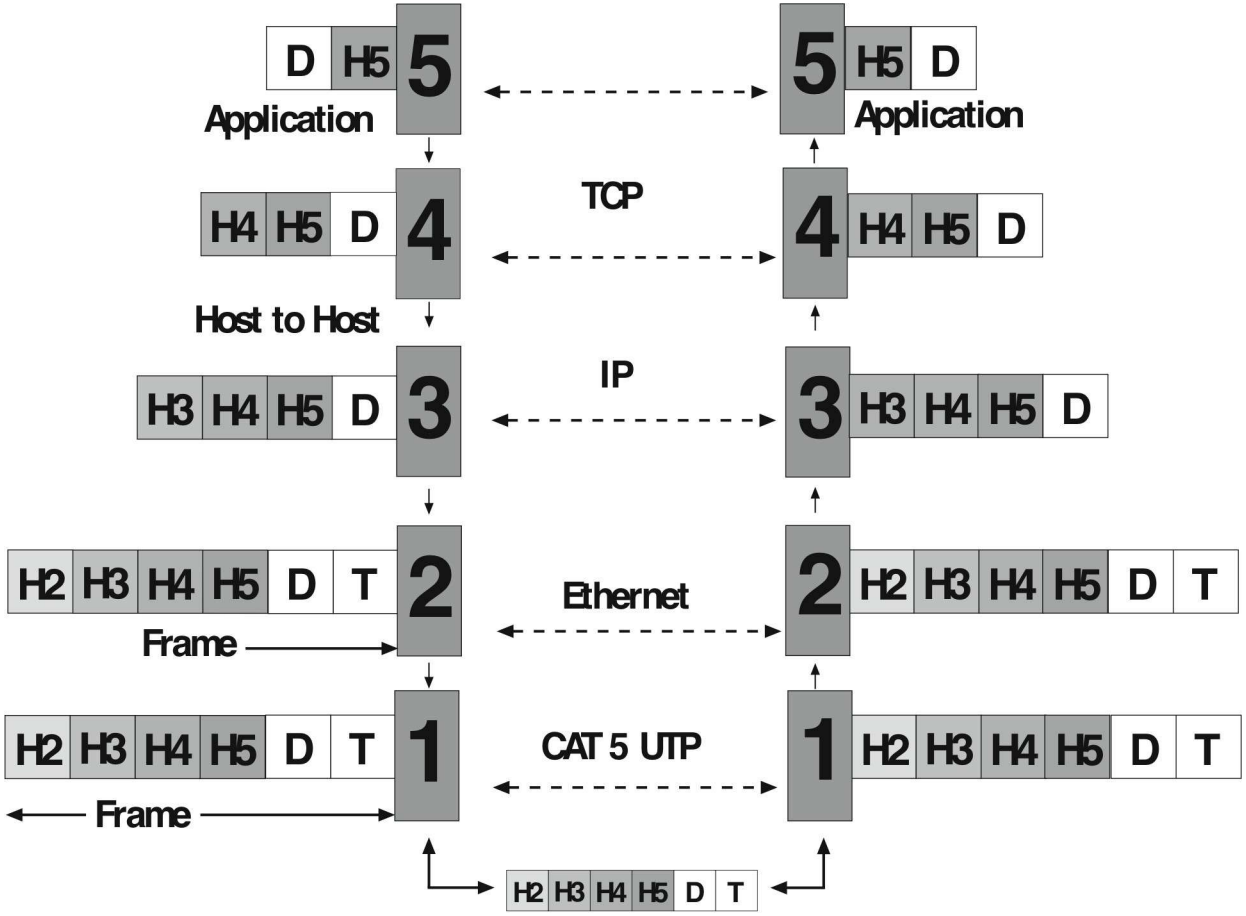
5.2.1. Layers 1&2

- Many technologies
- X.25
- Frame Relay
- T1, T3
- SONET (Synchronous Optical NETwork)

5.2.2. Big News

- These days, its almost all the Internet


OSI Reference Model
TCP/IP
7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data Link
1 Physical
Application 4
Host to Host 3
Internet Layer 2
Network Access 1


D
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Application
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Application
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TCP
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D
Host to Host
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IP
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Frame
Ethernet
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D
T
Frame
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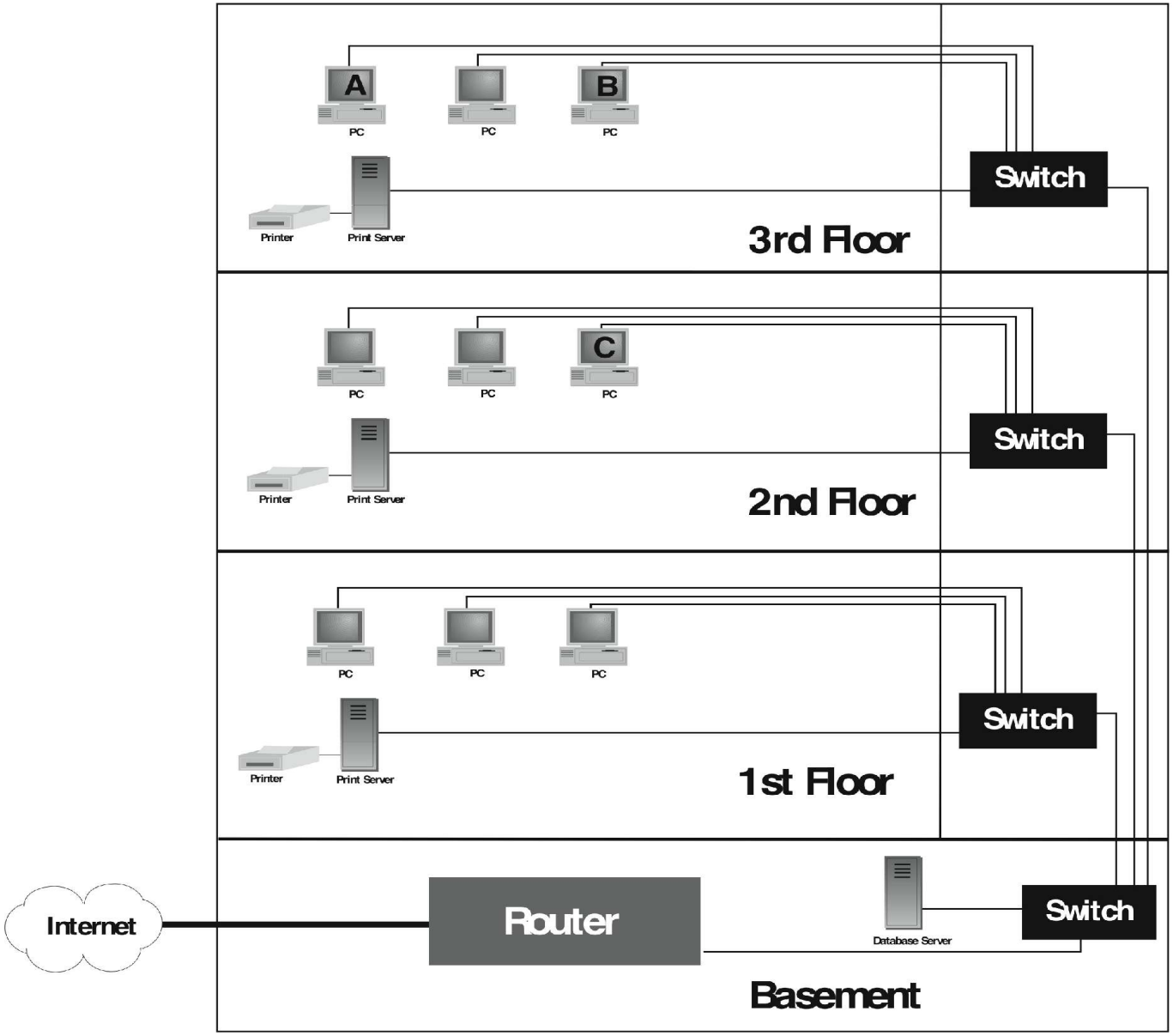
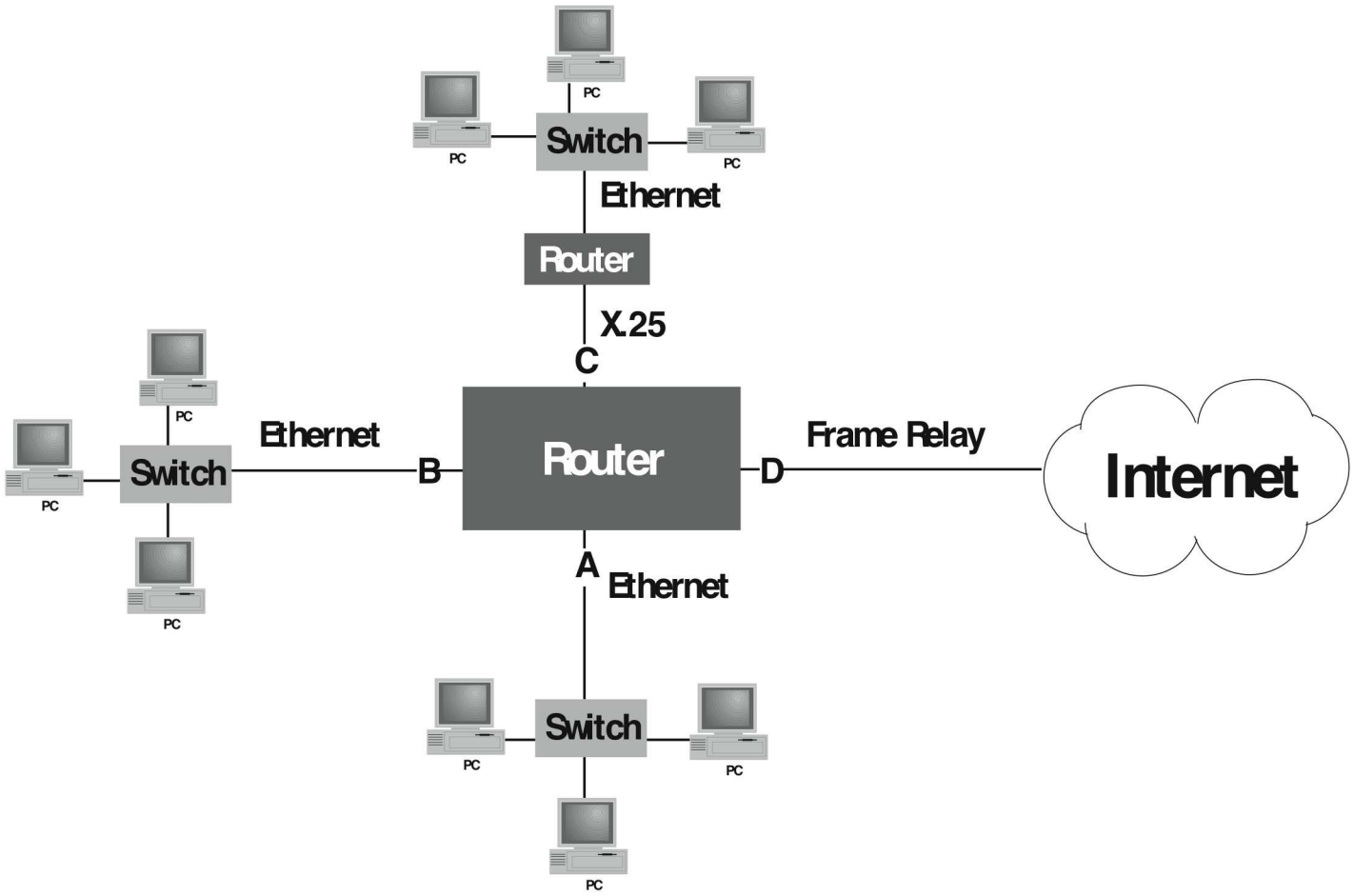
5.2.3. Layer 3

- Routing
- Network addresses such as Internet Protocol (IP) addresses
  - 151.174.6.4
- Hardware: Routers or “Layer 3 switches”
- DNS (Domain Name System -- or Service -- or Server)

6. Why the Internet?

- Open architecture
- Robust protocls
- ASCII
- Competitive markets
- Cross platform
- Client/server
- Bottom up development


A
PC
PC
B
PC
Printer
Print Server
Switch
3rd Floor
PC
PC
C
PC
Printer
Print Server
Switch
2nd Floor
PC
PC
PC
Printer
Print Server
Switch
1st Floor
Internet
Router
Database Server
Switch
Basement


PC
PC
Switch
PC
Ethernet
Router
X.25
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Switch
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PC
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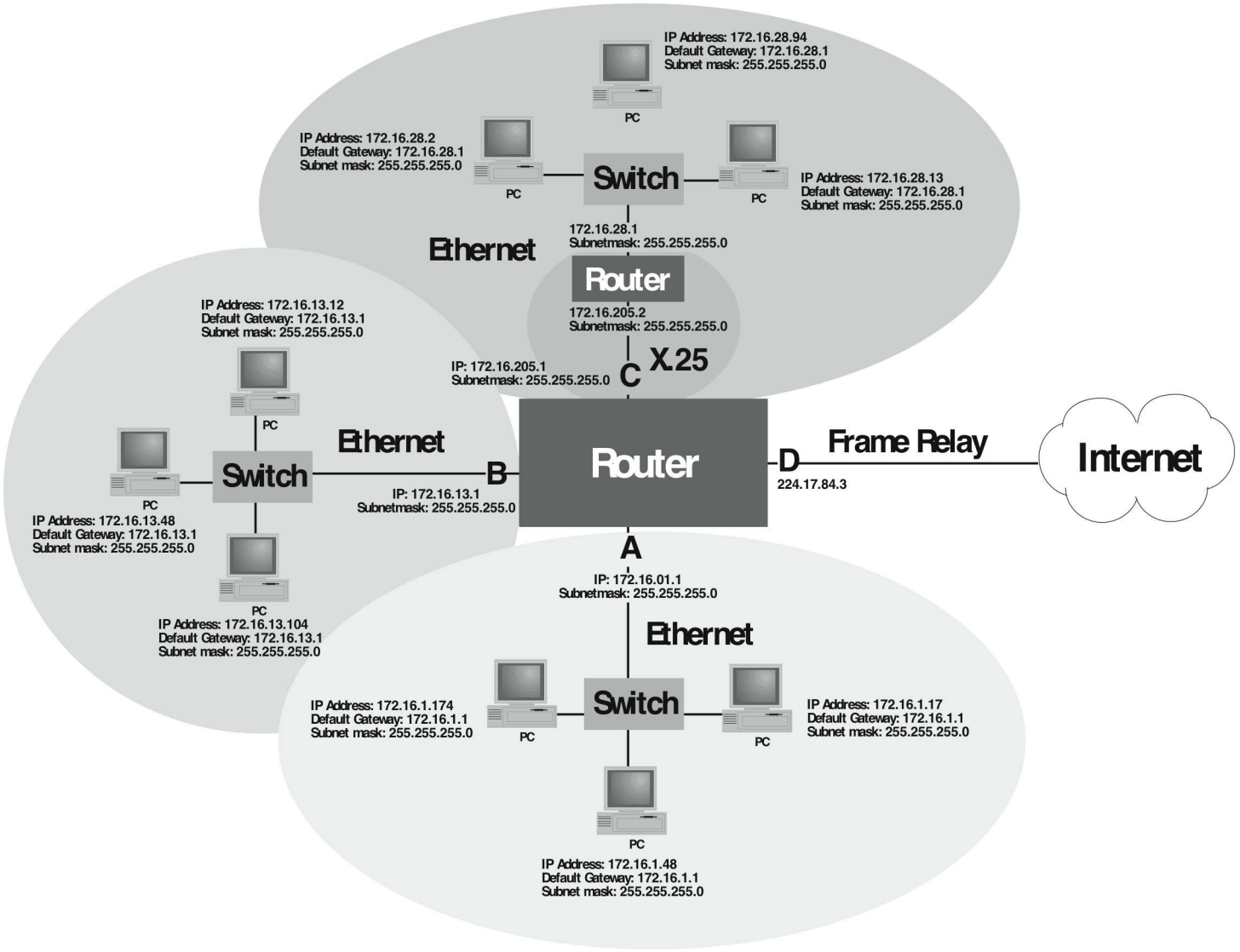
Router
D
Frame Relay
Internet
A
Ethernet
Switch
PC
PC
PC


IP Address: 172.16.28.94
Default Gateway: 172.16.28.1
Subnet mask: 255.255.255.0
PC
IP Address: 172.16.28.2
Default Gateway: 172.16.28.1
Subnet mask: 255.255.255.0
PC
Switch
PC
IP Address: 172.16.28.13
Default Gateway: 172.16.28.1
Subnet mask: 255.255.255.0
Ethernet
172.16.28.1
Subnetmask: 255.255.255.0
Router
172.16.205.2
Subnetmask: 255.255.255.0
IP: 172.16.205.1
Subnetmask: 255.255.255.0
C
X.25
IP Address: 172.16.13.12
Default Gateway: 172.16.13.1
Subnet mask: 255.255.255.0
PC
Ethernet
PC
Switch
B
Router
D
Frame Relay
Internet
IP: 172.16.13.1
Subnetmask: 255.255.255.0
224.17.84.3
IP Address: 172.16.13.48
Default Gateway: 172.16.13.1
Subnet mask: 255.255.255.0
PC
A
IP: 172.16.01.1
Subnetmask: 255.255.255.0
IP Address: 172.16.13.104
Default Gateway: 172.16.13.1
Subnet mask: 255.255.255.0
Ethernet
IP Address: 172.16.1.174
Default Gateway: 172.16.1.1
Subnet mask: 255.255.255.0
PC
Switch
PC
IP Address: 172.16.1.17
Default Gateway: 172.16.1.1
Subnet mask: 255.255.255.0
PC
IP Address: 172.16.1.48
Default Gateway: 172.16.1.1
Subnet mask: 255.255.255.0

Never take counsel of your fears

- drdata@molyneux.com